Contribution ID: **18** Type: **Poster**

Overview of Tritium Breeding and Activation of Fusion Blankets

The reliable design and effective deployment of tritium breeding blankets are critical challenges for realizing fusion energy. The fusion neutronics group at the University of Tennessee, Knoxville (UTK) has conducted integrated research focused on evaluating fusion blanket performance using the Fusion Nuclear Science Facility (FNSF) as a testbed. This research has analyzed TBR performance using rapid 1D reduced-order models and fully resolved 3D CAD-based geometries, including liquid Pb-15.7Li and a wide range of solid breeder systems that include Li-ceramics with Be-based neutron multipliers [1]. These studies include realistic material deviations, such as $Be_{12}Ti$ with excess Be, to evaluate fabrication-driven effects on breeding performance. This research has also addressed critical safety and maintenance challenges through comprehensive radioactivation analysis, including activation and decay-heat calculations to quantify material transmutation, radiological inventory, and waste classification for structural components [2,3]. Furthermore, shutdown dose rate (SDR) evaluations are performed using the rigorous R2S OpenMC workflow, comparing the maintenance feasibility of various blanket concepts. These studies were derived from a verified, open-source simulation where OpenMC-DAGMC is benchmarked against MCNP, SERPENT, and ORIGEN [3,4]. Comprehensively, this work establishes a consistent, open, and fully traceable methodology for assessing blanket concepts, identifying the neutronic trade-offs that govern tritium breeding sufficiency, activation hazards, and remote-handling requirements in next-generation fusion systems.

[1] Novais, F. S., Brown, N. R., & Maldonado, G. I. (2023). Tritium Breeding Ratio Evaluation of Solid Breeder Concepts for the FESS-FNSF. Fusion Science and Technology, 79(8), 961–972. https://doi.org/10.1080/15361055.2022.2161263
[2] Son N. Quang, Jonathan Wing, Nicholas R. Brown & G. Ivan Maldonado (2023) Activation Analysis for the Inboard Region of FNSF Using SERPENT, Fusion Science and Technology, 79:8, 973-988, DOI: 10.1080/15361055.2023.2185043
[3] S. N. Quang, N. R. Brown and G. Ivan Maldonado, "Testing the Activation Analysis for Fusion in OpenMC," in IEEE Transactions on Plasma Science, vol. 52, no. 9, pp. 4184-4190, Sept. 2024, doi: 10.1109/TPS.2024.3426323.
[4] Nikolas G. Nelson, Son N. Quang, Nicholas R. Brown & G. Ivan Maldonado (23 Apr 2025): Shutdown Dose Rate Analysis of Various Blanket Concepts, Fusion Science and Technology, DOI: 10.1080/15361055.2025.2478542

Speaker affiliation

University of Tennessee

Author: QUANG, Son (University of Tennessee)

Co-authors: NELSON, Nikolas (University of Tennessee); Dr BROWN, Nicholas (University of Tennessee); Prof. MALDONADO, G. Ivan (University of Tennessee)

Presenter: QUANG, Son (University of Tennessee)

Track Classification: LIBRTI Conference